Chapter 2
EXAMPLE ANALYSES FOR SELECTING AN ASPHALT CEMENT

Example 1. Calculating Pavement Temperature Index

The method for calculating the pavement temperature index for two construction sites is given in this example.

The average monthly maximum temperature and the difference above 75" F (23.9" C) for Site A and Site B are given below.

	Site A		Site B	
Month	Avg. Max. Temperature °F	Difference Above 75" F	Avg. Max. Temperature °F	Difference Above 75" F
Jan	60.5		29.8	--
Feb	68.5	--	27.8	--
Mar	73.7	--	43.0	
Apr	79.9	4.9	58.2	--
May	88.5	13.5	67.2	--
Jun	94.5	19.5	70.4	--
Jul	97.6	22.6	77.0	2.0
Aug	92.0	17.0	74.2	--
Sep	90.2	15.2	66.9	--
Oct	80.3	5.3	57.5	--
Nov	74.0	--	43.4	--
Dec	60.3	--	36.8	--
Cumulative Total		98.0		2.0

The temperature index at these sites is the sum of the increments of average monthly maximums above 75" F; therefore, the pavement temperature index for each site is as follows:

Site A = 98.0, cumulative °F (54.4, cumulative °C)

Site B = 2.0, cumulative °F (1.1, cumulative °C)

Based on Table 4 of Enclosure 1, Site A is a hot region, and Site B is a cold region. Site B requires the use of the PVN method to select an asphalt cement.

Example 2. Asphalt Cement Selection in a Hot Region

A parking lot should be built in a region that has a pavement temperature index of 98, cumulative °F (54.4, cumulative °C).

An asphalt supplier can provide asphalt cements that meet the requirements in Table 1 of Enclosure 1 (from ASTM D 3381). Viscosity and penetration data for the asphalt cements are given below.

	AC-10	AC-20	AC-40
Viscosity, 140" F, P	872	2,200	4,104
275° F, cSt	298	435	605
Penetration, 77° F, 0.1 mm	123	70	46

From Table 4 of Enclosure 1, an asphalt cement that has a penetration of approximately 60 to 70 should be selected. The AC-20 asphalt cement should be selected for this pavement.

Example 3. Asphalt Cement Selection in a Warm Region

A street should be constructed in a region that has a pavement temperature index of 42, cumulative °F (23.3, cumulative "C).

An asphalt supplier can provide asphalt cements that meet the requirements in Table 1 of Enclosure 1. Viscosity and penetration data for the asphalt cements are given below.

	AC-5	AC-10	AC-20
Viscosity, 140° F, P	560	1,120	2,170
275" F, cSt	180	335	450
Penetration, 77° F, 0.1 mm	145	96	70

Based on Table 4 of Enclosure 1, an asphalt cement that has a penetration of approximately 85 to 100 should be selected. The AC-10 asphalt cement is selected.

Example 4. Asphalt Cement Selection in a Cold Region

At Fort Drum, NY, a heavy duty open storage area (design index of 10) for use by 50,000 lb forklift trucks has to be constructed in a region with a pavement temperature index of 2, cumulative °F (1.1, cumulative °C) and a DFI of 2,300 degree-Fahrenheit-days (1,278 degree-Celsius-days) calculated using TM 818-2.

An asphalt supplier can provide two asphalt cements that meet the requirements in Table 1 of Enclosure 1. Viscosity and penetration data for the asphalt cements are given below.

	AC-Z.5	AC-5
Viscosity, 140" F, P	280	466
275° F, cSt	140	220
Penetration, 77" F, 0.1 mm	296	240

Analysis and Asphalt Selection

The climatological data allow classification of the site by temperature region and allow an estimate of pavement temperature. According to Table 4 of Enclosure 1, the pavement temperature index classifies the site as a cold region where the PVN method should be used to select the grade of asphalt cement, The DFI allows the use of Figure 2 (Enclosure 1) to estimate a minimum pavement temperature at a 2-in. (5 cm) depth. From Figure 2, a minimum anticipated pavement temperature is about -22" F (-30" C).

Table 5 of Enclosure 1 shows that this cold region can be further classified as a moderately cold region since its DFI is less than 3,000 degree-Fahrenheit-days. Table 5 also indicates that the required PVN of the asphalt selected must be greater than -0.5 for a design index of 10. This will minimize low temperature pavement cracking.

Now, PVN values must be determined for the available asphalt cements. This can be done by either plotting penetration and viscosity at 275" F (135" C) in Figure 1 of Enclosure 1 or by using PVN equations. If the details of Figure 1 are not sufficient to accurately determine PVN values, equations should be used.

The general PVN equation1 is as follows:

$$PVN = \frac{(L - X)(-1.5)}{(L - M)}$$

where

L = logarithm of viscosity in centistokes at 275" F (135° C) for a PVN of 0.0 at the given penetration

X = logarithm of viscosity in centistokes at 275" F (135° C) of a given asphalt

M = logarithm of viscosity in centistokes at 275° F (135° C) for a PVN of -1.5 at the given penetration

Values of X can be determined directly from asphalt cement viscosity data as provided in this example, but values of L and M are a function of the penetration values of each asphalt. Equations for the values of L and M are:

$$L = 4.25800 - 0.79674 \log (Pen)$$

[1] McLeod, N. W., "Using Paving Asphalt Rheology to Impair or Improve Asphalt Pavement Design and Performance", Asphalt Rheology: Relationship to Mixture, ASTM STP 941, 0. E. Briscoe, Ed., American Society for Testing and Materials, Philadelphia, 1987.

and

$$M = 3.46289 - 0.61094 \log (PEN)$$

where PEN = penetration at 77" F (25" C) of a given asphalt cement.

Calculated PVN values of the two available asphalt cements are:

PVN = -0.638 for AC-2.5

PVN = -0.081 for AC-5

Based on Table 5 of Enclosure 1, an asphalt cement that has a PVN greater than -0.5 and lies on or to the right of the minimum temperature diagonal line should be selected. The AC-5 asphalt cement is selected because it has a PVN of -0.081 and lies to the right of the -22" F temperature diagonal line. This asphalt cement satisfies the requirements of Table 5 and should prevent low-temperature pavement cracking.

Example 5. Asphalt Cement Selection in a Warm Region

A parking lot should be constructed in a region that has a pavement temperature index of 42, cumulative °F (23.3, cumulative °C).

An asphalt supplier can provide asphalt cements that meet the requirements in Table 2 of Enclosure 1. Viscosity and penetration data for the asphalt cements are given below.

	AR-1000	AR-2000	AR-4000
Viscosity, 140° F, P	851	1,962	3,544
275" F, cSt	162	247	334
Penetration, 77" F, 0.1 mm			
Original	141	87	53
Residue	99	55	39

Based on Table 4 of Enclosure 1, an asphalt cement.that has a penetration of approximately 85 to 100 should be selected. The AR-2000 asphalt cement is selected based on the original penetration of the material.